

REMARKS

Review and reconsideration on the merits are requested.

Applicants amend claim 1 into the form that was submitted to the EPO.

The reason for this is that WO 96/38945 discloses the coating of a copolymer of an n-alkyl acrylate or methacrylate and acrylic or methacrylic acid or its ester, cis-polybutadiene, an ethylene-propylene rubber, poly(4-methylpentene), or polydimethylsiloxane onto a microporous polyethylene membrane (cited by the EPO).

The WO reference was filed with the Information Disclosure Statement of 2007-01-19.

The Examiner has relied upon JP 2000-133236 (JP '236).

The Examiner's position is set forth in the Action and will not be repeated here except as necessary to an understanding of Applicants' traversal which is now presented.

Traversal

To distinguish claim 1 from JP '236, claim 1 is amended from "a microporous composite membrane" to "a lithium secondary battery separator," and the polypropylene is restricted to one having "a racemic diad fraction [r] within a range of 0.16-0.84." Further, the properties of the polypropylene and the microporous composite membrane are recited in detail in amended claim

1. The requirements added to claim 1 are described in the specification as follows.

Added Requirements	Specification
A racemic diad fraction [r] within a range of 0.16-0.84	Paragraph [0070]
0.1-5 g of said coating layer is formed on said microporous polyethylene membrane per 1 m ²	Claim 2
An air permeability (converted to the value at 25-μm thickness) of 100-3,000 seconds/100 cc	Paragraph [0014]
A porosity of 25-95%	Paragraph [0013]
A pin puncture strength of 5,000 mN/25 m or more	Paragraph [0015]
A shutdown temperature of 120-140°C	Paragraph [0016]
A meltdown temperature of 155°C or higher	Paragraph [0017]

A battery capacity recovery ratio after storing at 80°C for 30 days [(battery capacity after storing/initial battery capacity) x 100] of 70% or more in a lithium secondary battery	Paragraph [0018]
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The most important feature of claim 1 is that the microporous composite membrane has a battery capacity recovery ratio of 70% or more after being stored at 80°C for 30 days in a lithium secondary battery. This feature is obtained by meeting the requirements that the separator is composed of a microporous polyethylene membrane and a polypropylene coating layer, that the polypropylene has a racemic diad fraction [r] within a range of 0.16-0.84 and a solubility of 0.5 g or more in 100 g of toluene at a temperature of 25°C, and that 0.1-5 g of the coating layer is formed on the microporous polyethylene membrane per 1 m². The amount of the coated layer applied is correlated with the thickness of the coated layer. With the racemic diad fraction, solubility and thickness limited as above, a thin, uniform polypropylene coating is obtained, overcoming the disadvantage that a microporous polyethylene membrane is vulnerable to oxidation when stored at high temperatures (Paragraph [0003]), without increasing the thickness of the microporous membrane.

JP '236 disclose a separator for a nonaqueous electrolyte secondary battery formed by a microporous, three-layer polyethylene/polypropylene/polyethylene composite membrane with a polyethylene/polypropylene weight ratio of more than 1 and less than 3. Referring to JP '236, the Examiner has noted that the polypropylene has solubility of 0.5 g or more in 100 g of toluene at a temperature of 25°C, and that 0.1-5 g of the polypropylene coating layer is formed on the microporous polyethylene membrane per 1 m².

However, JP '236 neither describes the specific character or quality of the polypropylene used nor suggests the amount of the polypropylene coating layer. The microporous

polypropylene layer of JP '236 is not a coating layer, rather, it is a microporous stretched film laminated to a microporous polyethylene film by press-bonding. Because the polyethylene/polypropylene weight ratio is more than 1 and less than 3, the thickness of the polypropylene is 6.25-12.5 μm when the total thickness of the microporous polyethylene membrane is 25 μm as described in Examples 1-3.

With respect to the thickness of the polypropylene coating layer of the present invention, it cannot be precisely determined with respect to the amount of polypropylene applied because some of the polypropylene applied enters into the micropores of the microporous polyethylene membrane. Accordingly, in order to provide a basis for comparison, Applicants have used the data of thickness in the Examples in the present application to determine the thickness of the coated layer. The data of thickness in Examples are given in the Table below:

Example	Coated PP ⁽¹⁾ (g/m ²)	T _{PP} ⁽²⁾ (μm)	T _{PP} ⁽³⁾ (μm)	T _{PE} ⁽⁴⁾ (μm)	T _{CM} ⁽⁵⁾ (μm)
1	0.78	0.2	0.1	23.2	23.4
2	1.68	0.7	0.35	23.2	23.9
3	2.25	1.1	0.55	23.2	24.3
4	0.96	0.3	0.15	23.2	23.5
5	1.21	0.6	0.3	23.2	23.8
6	0.83	0.6	0.3	23.2	23.8
7	0.51	0.3	0.3	23.2	23.5

Note:

(1) The amount of the coated polypropylene layer formed on the microporous polyethylene membrane per 1 m².

(2) T_{PP}, represents the thickness of the coated polypropylene layer, which is calculated by the equation $T_{PP} = T_{CM} - T_{PE}$.

(3) N represents the number of the coated polypropylene layer(s). When the microporous composite membrane has the polypropylene coating layers on both surfaces of the

microporous polyethylene membrane (Examples 1-6), $N=2$. When the microporous composite membrane has the polypropylene coating layer only on one surface of the microporous polyethylene membrane (Example 7), $N=1$.

(4) T_{PE} represents the thickness of the microporous polyethylene membrane.

(5) T_{CM} represents the thickness of the microporous composite membrane.

From the values of Coated PP (g/m^2) and T_{PP}/N (μm) in the Table above, the thickness of the polypropylene coating layer of $0.1\text{-}5 \text{ g/m}^2$ was estimated by the following method. First, the average of the values of $[T_{PP}/N (\mu\text{m}) / \text{Coated PP} (\text{g/m}^2)]$ was calculated to be $0.25 \mu\text{m/gm}^2$.

Next, by using the average value $0.25 \mu\text{m/gm}^2$, the thickness of polypropylene coating layer of $0.1\text{-}5 \text{ g/m}^2$ was estimated to be about $0.02\text{:}1.3 \mu\text{m}$.

Therefore, the thickness of the polypropylene coating layer of the present invention is less than the thickness of the microporous polypropylene layer of JP '236. Accordingly, JP '236 does not suggest the amount of the polypropylene coating layer of the present invention.

The effect of the amount of the polypropylene coating layer of $0.1\text{-}5 \text{ g/m}^2$ is clear from a comparison of Example 1 and Comparative Examples 2 and 3 in the present application. The separator of Example 1, where the amount of the polypropylene coating layer formed was 0.78 g/m^2 , had a battery capacity recovery ratio of 75% and good uniformity of the coating layer.

On the other hand, the separator of Comparative Example 2, where the amount of the polypropylene coating layer formed was 0.03 g/m^2 , had a battery capacity recovery ratio of only 60%.

The separator of Comparative Example 3, where the amount of the polypropylene coating layer formed was 5.81 g/m^2 , had a battery capacity recovery ratio of only 65% and poor uniformity of the coating layer.

The separator of the present invention has a coated polypropylene layer which is very thin and uniform. Such a thin polypropylene layer cannot be obtained by a laminating method.

A separator having such a coated polypropylene layer of the present invention has excellent oxidation resistance, without increasing the thickness of the microporous membrane.

Moreover, because some of the coated polypropylene enters into micropores in the microporous polyethylene membrane, the separator of the present invention is more excellent in oxidation resistance than a separator having a polypropylene layer formed only on the surface of a microporous polyethylene membrane.

Such a separator is obtained only by coating polypropylene which meets the requirements of the present invention.

On the other hand, because the separator of JP '236 has a microporous polypropylene layer only as an inner layer, the separator of JP '236 is poor in oxidation resistance as compared to the separator of the present invention. The separator of JP '236 is only improved in its shape retention property at high temperatures.

Moreover, JP '236 does not describe any specific character or quality of the polypropylene used in JP '236, only that it is preferable to use polypropylene from an economical viewpoint (Paragraph [0019]). Accordingly, Applicants believe that JP '236 uses a general polypropylene produced using a Ziegler-Natta catalyst.

Assuming that Applicants' assumption is correct, the polypropylene used in JP '236 could not have a racemic diad fraction [r] within a range of 0.16-0.84, because polypropylene produced using a Ziegler-Natta catalyst is isotactic [a racemic diad fraction [r] represents the syndiotacticity of polypropylene (Paragraph [0069] of the specification)].

In distinction to JP '236, the polypropylene used in the present invention is produced using metal complex catalysts (Paragraph [0074], and is partially syndiotactic (Paragraph [0069] and [0070]).

Applicants have conducted experimentation comparing the microporous composite membrane produced using polypropylene meeting the requirements of claim 1 with those produced by using polypropylene failing to meet the requirements, which experimentation is attached. As is clear from Table A in the comparative experiments attached hereto, microporous composite membranes obtained by using polypropylene failing to meet the requirements of the present invention do not have the required battery capacity recovery ratio.

Considering the above discussion, in Applicants' view it is quite clear that JP '236 fails to provide a lithium secondary battery separator, which should be thin and uniform, having a battery capacity recovery ratio of 70% or more after storing at 80°C for 30 days. This is because the polypropylene used in JP '236 is different from polypropylene having a racemic diad fraction [r] within a range of 0.16-0.84 and solubility of 0.5 g or more in 100 g of toluene at a temperature of 25°C, and the microporous polypropylene layer is not in the form of a 0.1-5 g of polypropylene coating layer formed on a microporous polyethylene membrane per 1 m².

Thus, it is submitted that the above discussion, the amendments to the claims and the attached Comparative Experimentation, establish that the claims herein are unobvious over JP '236, and withdrawal of the rejection and allowance are requested.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

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Respectfully submitted,



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